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ABSTRACT

This project developed a lesson authoring system, a component which provided communications between students and teachers using electronic mail, and calculus lessons which were formatively evaluated with 20 students at four high schools. The authoring system utilized word processors to write the lessons and a BASIC computer program to execute the word processor files. Interactive lessons written on a word processor using one operating system were transferred to a different operating system using communications software. To maintain computer compatibility, worksheets were used to present graphics material. Students and remote teachers communicated through electronic mail (e-mail). The lessons saved student responses to questions in a form which was easily included in e-mail messages. The remote teacher wrote answers to the questions in a form which was returned to the student on e-mail. These answers were executable as lessons and merged into existing lessons using word processing functions. This created a dynamic software library which was updated as student questions were answered. This report includes the cost of continuing the course and the student evaluation of the course. (Author/YP)

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ED307116

Final Report of

Excellence in Ed Grant -

Independent Study Calculus via Computer Software

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Grant Number G008690028

Project Number 171AH60014

Submitted by the Chestnut Ridge School District

SE 050 568

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ABSTRACT

An Excellence in Education Grant from the U. S. Department of Education to the Chestnut Ridge School District developed a method to provide independent study lessons to students whose educational settings deny them access to certain courses. This project developed a lesson authoring system, a component which provides communications between students and teachers using electronic mail, and calculus lessons which were formatively evaluated with 20 students at four high schools.

The authoring system utilizes word processors to write the lessons and a BASIC computer program to execute the word processor files. The authoring system can be learned in less than a day and works with any computer brand and word processor which saves text as ASCII files. The BASIC program is needed for the computer brand which executes the lessons. Interactive lessons written on a word processor using one operating system can be transferred to a different operating system using communications software. Computer compatibility between author and user is no problem. To maintain computer compatibility, worksheets are used to present graphics material.

Students and remote teachers communicate through electronic mail. The lessons save student responses to questions in a form which is easily included in e-mail messages. The remote teacher writes answers to the questions in a form which is returned to the student on e-mail. These answers are executable as lessons and can be merged into existing lessons using word processing functions. This creates a dynamic software library which is updated as student questions are answered.

To: U. S. Department of Education

From: David Popp, Project Director

Subject: Final Report, Excellence in Education Project

Date: January 5, 1987

INTRODUCTION

The proposal for this Excellence in Education Grant originated with a need to provide a calculus course for the students at Chestnut Ridge High school and other schools where conditions prevent the offering of advanced courses.

The underlying philosophy of the project was that small schools can find new methods to offer advanced courses to their students if they can learn to cooperate and share resources. Chestnut Ridge School District owned a Tandy 6000 multiuser computer which included the software necessary to provide electronic mail. We would offer the services of our computer to provide free electronic mail to a group of small schools which expressed an interest in joining a cooperative venture to provide a calculus course for our students.

The lessons would be provided as computer lessons and the electronic mail would link the students to each other and a computer teacher. The grant funds would be used to develop the delivery system and lessons which would be made available to interested schools.

Our proposal was originally written as a two year development project scheduled to begin in February of 1986. When we were funded for one year with a starting date of July 1987, it became necessary for us to request a change in the scope of the project.

The objectives and goals of the project as stated in the proposal and modified on September 5, 1986 are as follows:

1. To develop the beginnings of an independent study calculus course where lessons can be done by computer and the students are linked to a teacher by electronic mail. This would include the development of a delivery system for the instruction.

2. Determine the feasibility of schools combining efforts to offer specialized courses for their students.

3. Provide an independent study course for mentally gifted students.

4. Provide an opportunity for teachers at other schools to contribute to a project which is different from their normal teaching experiences.

5. To have the course online in November of 1986.

6. Determine the cost of continuing the course after the development money has been spent.

7. Evaluate the cost effectiveness of providing instruction by this method.

8. Evaluate student achievement.

DETAILED DESCRIPTION OF TREATMENT

HISTORY OF THE PROJECT

The Chestnut Ridge School District received notification of the grant award on July 15, 1986. Initial organizational activities were directed toward notifying the schools which had expressed interest in participating in the project and the development of a computer program which would allow us to write lessons in an efficient manner.

Letters were sent to each of the school districts which had been listed in our proposal and several others who had expressed interest after the proposal was written. Northern Bedford, Shanksville Stoneycreek, Southern Fulton, West Snyder (Midd-West school district), Middleburg (Midd-West school district), and Portage responded to our letter and became the test group along with students at Chestnut Ridge.

We faced a problem with lesson development due to the fact that three different brands of computer are in use at these high schools. Developing lessons written as computer programs would slow development to the point of impracticality. A computer program was written in BASIC, called the Reader program, to meet the particular needs of this project. A version of the program was written for Apple, IBM compatibles, and Commodore. A student at Chestnut Ridge later adapted the program to run on his Atari home computer. The program allows the writing of lessons on word processors of any brand and permits the translation of lessons without reprogramming. The details of this program will be discussed in a later section.

Development of the Reader program began in August of 1986. The IBM and Apple Versions were completed in January of 1987. Due to the fact that our current students are not using Commodore computers in their schools, the Commodore version has not been completed to date. This will be necessary if this project is expanded for students to work in their homes. We have found this to be the most popular brand of home computer among our students.

While the Reader program was being developed by David Popp, Wayne Henderson developed programming on the Tandy 6000 to provide a menu driven communications system. The need for this programming parallelled a need in the Small and Part-time Farmer project. The background programming for the communications was paid by the farming project at a substantial savings to this project.

Annalee Henderson began writing calculus lessons in October of 1986. As the programming phase for the Reader program neared completion in January of 1987, the communications system was in place and a first draft of lessons had been written for chapters 1 and 2 of the text.

We began to make site visits to participating schools in January 1987. During these visits we installed modems on the computers which would be used for telecommunications and demonstrated the use of the system to the students. The students were given guided practice on the system and were introduced to the lesson software.

A set of introductory lessons were developed to explain the use of the lesson software to the students. Once all schools had been visited and the introductory lessons written, we were ready to begin the course. This was accomplished by March 1, 1987.

Student participation during the spring was disappointing. Among the factors which worked to discourage the students was the late starting date, lack of a regular scheduled period to work on the lessons, problems with poor phone lines, and the time lag between the time of our visit and the arrival of the lessons.

We had completed nine months of program development and faced the prospect of having a program with no funding to put it into practice. We made several proposals and presentations in the following months in an attempt to attract funding for the continuation of the project.

A proposal was made to the 34 school districts of Appalachia Intermediate Unit 08 to form a telecommunications consortium which would offer the calculus course and develop new materials which could be shared. We proposed a $450 membership fee to provide funds for additional development and a second Tandy 6000 computer. Only two districts responded to the proposal.

The same proposal was presented to the Pennsylvania Association of Small and Rural Schools. While it was enthusiastically received at the meeting, none of the superintendents contacted us later. An offer from the Pennsylvania Department of Education (PDE) led to a decision not to pursue the superintendents further. With additional funding in hand we were able to concentrate our efforts on developing the course further and establishing a performance record before making any further overtures to other districts.

One PDE offer came as a result of our presentation at the Pennsylvania Association of Rural and Small Schools. One of the presenters at that conference was Joe Bard of PDE who has an interest in distance education. Discussions with him lead to our proposal to conduct a workshop explaining the project at the PDE Curriculum Conference and an award of $11,000 in Chapter 2 Reallocated Funds.

The second PDE connection came when John McDermott, senior science adviser, saw the possibility of using this system to provide a distance education option for schools which cannot find certified physics teachers. A meeting between McDermott, Popp, and Ron Simanovich, ESEA Regional Coordinator, resulted in a $40,000 contract which would train teachers to use our system to produce math and physics modules and supervise the testing of the modules in schools.

The awarding of the contract assured the continuation of the project into a second year. We could use the remaining Excellence in Education funds to develop additional lessons over the summer of 1987 and to start the course in the fall. The contract could assume the costs of continuation when the students began using modules developed with those funds.

The Chapter 2 funds supported the development of a mini-course teaching the fundamentals of on-line database searching, writing of additional calculus lessons, and the purchase of a second Tandy 6000 computer. The database search course will be disseminated at no cost to receiving schools in the near future.

The calculus project also attracted the attention of our regional vocational education consultant and resulted in a $40,000 ESEA Title II-B curriculum development grant. Under this project personnel at Chestnut Ridge are using the system developed by the Excellence in Education Grant to develop a tele-accounting course. This course will teach fundamentals of accounting and data transmission via telecommunications.

Under the PDE contract Math/Physics contract, we trained teachers to use our system at the Pennsylvania Department of Education Curriculum Conference in July of 1987 and conducted an additional workshop in instructional development in November of the same year. These teachers are being paid to write additional modules. The project provides funds for the testing of the modules. The PDE contract has in effect continued the project begun under the Excellence in Education Grant into the 1987-88 school year.

Lessons developed with Excellence in Education funds include an introductory unit which teaches students how to use our software to do lessons and calculus lessons into chapter 3 of the Howard Anton calculus text we are using for our course. The introductory and chapter 1 units performed satisfactorily but when students encountered the chapter 2 lessons they experienced major difficulties. We attributed this to the fact that chapter 1 was a review chapter while chapter 2 contained material which was new to the students.

The PDE project had provided a large block of time with Dr. Kyle Peck at Penn State University to develop a training course and manual to be used by teachers writing lessons. The chapter 2 lessons were rewritten using the procedures established in the training course and are being completed by students at this time. The remaining materials will be adapted to conform to the recommended guidelines of our training manual.

We served a total of 20 students at four schools this year. Lessons were first tested at Chestnut Ridge then distributed to the other schools. Many lesson bugs were detected in-house but some still were distributed with the lessons. This project officially ended December 31, 1987. A student evaluation questionaire was distributed before the students left school for Christmas vacation. Student responses from those evaluations indicated the lessons were weak in their design. Informal discussions with the students at Chestnut Ridge indicated the chapter 2 lessons were even more difficult for students to understand.

It was decided that the chapter 2 lessons would be rewritten and retested at Chestnut Ridge before being distributed to students at other schools. This proved to be a sound decision. The end of year evaluations indicated a marked improvement in the quality of the lessons. A very important lesson was learned from this experience. Outstanding teachers will not necessarily write outstanding computer lessons. We are currently having teachers develop lessons in a series of discrete step which we are guiding. Lessons developed using the recommended guidelines of our training manual have proven to be superior to those written by teachers who are untrained with respect to instructional design.

The rewriting of the chapter 2 lessons placed us in the position of being only a few days ahead of the students. This prevented us from pushing the students to complete lessons at the same pace they would in a regular class and also prevented the inclusion of evaluations within each section of lessons. As a result we were unable to gather a large amount of test data for this project year. The data which was collected will be discussed in detail in a later section of the report.

This project has been shared with educators at eight different workshops and conferences. It was presented to 34 superintendents of schools at an Appalachia Intermediate Unit 08 meeting, a group of teachers in a computer literacy class at the University of Pittsburgh at Johnstown, the spring meeting of the Pennsylvania Association of Rural and Small Schools, the Pennsylvania Department of Education Curriculum Conference, the National Science Supervisors Association Leadership Institute, the National Rural and Small Schools Consortium convention, the Pennsylvania Science Teachers Association convention, and the Pennsylvania Science Supervisors Association annual meeting.

These presentations have created an awareness of this project and in some cases have resulted in continued financial support. Two PDE grants resulted from these efforts, and Appalachia Intermediate Unit 08 recently contracted with us to complete a four credit in-service course. This course will train teachers to use CRISP to develop and share units for gifted education. This training course is a direct descendent of the telecommunications consortium proposal which was presented at the Intermediate Unit Meeting in March of 1987.

At this time prospects for funding a third year of the project through PDE look good. We also have a proposal pending with Johns Hopkins University to test our lessons with gifted students who have been identified by the Center for Talented Youth at Johns Hopkins. These students take the SAT test in their seventh grade year. Students with high scores qualify for special programs which in some cases accelerate their mathematics to the point where they are ready for calculus as early as ninth grade. If these proposals are funded we will train these students in telecommunications and test the lessons in an environment which will be as close to the original plan as we have come.

THE LESSON AUTHORING SYSTEM

A fundamental premise of this project has been that small schools will not readily adopt any course which requires more than a minimal investment on their part. Our objective is to get this course into the hands of as many needy students as possible. If we are to accomplish our objective we must keep the implementation costs at a minimum.

With this in mind we designed a lesson authoring system which allows us to produce lessons usable by any brand of computer found in schools without the purchase of expensive software. The solution arose through our experience with the Small and Part Time Farmer project which had purchased the Tandy 6000 computer and was using it for telecommunications. Computers can send information through phone lines in a standardized format called ASCII. The communications software that a computer is using translates the ASCII into signals which can be understood by that particular computer. Information which has been sent in ASCII by an IBM computer can then be received by an Apple or any other brand and translated by the communications software.

Our solution was to write a computer program in the BASIC language for each computer brand we would be using. Each program performs the same functions but has unique statements depending on the version of BASIC being used. The program reads information which has been stored on the disk in ASCII characters. We call the program Reader.

The lessons are then written with a word processor and saved to disk as ASCII characters. The Reader program can then load the ASCII characters into memory. As the program executes, it searches for defined symbols which control the display of screens and asking of questions. The symbols are typed in as the lesson is written.

Since these lessons are saved in ASCII, they can be transmitted to other computer brands using communications software. It is possible to send a new or corrected lesson to a student or to send the answer to the student's question in lesson form using electronic mail.

When a lesson is written on a computer that the author is comfortable using it is transmitted to the other computer brands. This eliminated the problem of writing a computer program for each brand of computer for each lesson.

When questions are asked of the student, the Reader program saves the responses in memory. These student answers are saved to disk as the student exits the lesson. This creates a record of the student's work for the day and provides feedback to the lesson author. These answer files can be printed out for each lesson and evaluated for the number of correct responses to each question. This provides documentation of weak segments of the lessons which can then be modified for future use.

The answer files are also in a form (ASCII) which can be transmitted over the phone lines to a teacher at a remote site. We planned to use this feature as a part of the communication between the student and teacher when there is difficulty with a lesson.

The Reader program has an option which permits the student to write a question to the teacher when there is difficulty with the lesson. The question is merged with the student's answer file for that lesson and saved in ASCII. This file can be electronically mailed to a remote teacher. The teacher can read the question and answer file. The answer file indicates the student's understanding of the lesson. This can guide the teacher in the formation of a response.

The responses is written in the form of a lesson and transmitted by electronic mail to the student. The answers can become a part of future lessons. With student responses guiding the revision of the lessons, they become a self correcting system which can evolve as long as students have questions and teachers have the funding for continued upgrading.

ANTICIPATED AND ACTUAL OUTCOMES

ACHIEVEMENT OF OBJECTIVES

Objective 1: To develop the beginnings of an independent study calculus course where lessons can be done by computer and the students are linked to a teacher by electronic mail. This would include the development of a delivery system for the instruction.

Objective 1 was completed with the development of the Reader program and lessons into chapter 3. We did have a problem with the first set of lessons written for chapter 2. Newer versions of the lessons written using the guidelines developed by the PDE contract have caused less problems for the students. It will be necessary to rewrite the remaining lessons using the new guidelines.

Objective 2: Determine the feasibility of schools combining efforts to offer specialized courses for their students.

Of the 17 schools contacted at the beginning of our project, six elected to join us. Of these six four remain today. The schools which dropped out offered calculus in 1986-87 but were using the course as independent study for enrichment. We have no data to indicate why the other schools from the original list did not elect to join with us.

We have located teachers in several of the participating schools who have produced materials for the project. We have been able to share resources in that respect. The project has not progressed to the point where we can determine if a group of schools can band together to solve a common problem.

The in-service training designed for Appalachia Intermediate Unit 08 will provide a new opportunity for sharing to occur. The materials produced at these workshops will become available on our telecommunications system and shared by all.

We do not have a definitive answer to objective 2 at this time. The following statements have no supporting hard evidence but are based on our impressions of our attempts to encourage schools to organize to solve common problems. Our opinion is that there is little chance of a group of schools initiating a curriculum development project such as this. If grass roots projects like this one are to occur, they will need to be driven by one school with a commitment to the project. Commitment at Chestnut Ridge is what has kept this project moving forward.

Schools will not be likely to risk funds on a consortium proposal such as ours until the proposing school becomes a recognized expert at developing course materials. Schools might be more inclined to respond to a consortium proposal which originates from a university or some other institution which is perceived to have expertise in curriculum development. We will continue to attempt to build bridges to other schools. We may have a better answer to this question in the future.

Objective 3: Provide an independent study course for mentally gifted students.

We have not provided a course for gifted students but we believe we have made a beginning. The delivery system is in place and approximately 90 lessons have been completed. If our proposal with Johns Hopkins is approved we will strengthen the link with gifted education.

The in-service course developed for Appalachia Intermediate Unit 08 will teach CRISP and produce units for gifted students during the actual training session.

Objective 4: Provide an opportunity for teachers at other schools to contribute to a project which is different from their normal teaching experiences.

The opportunity to work in the project was offered to the teachers of each of the participating schools. Two teachers from the six schools which joined the project have made significant contributions and remain with the project under the PDE contract. A third teacher, Annalee Henderson, has worked with the project while having no official school district connection.

Three of the four teachers involved in lesson development have been recognized for teaching excellence. One was a Presidential Award for Excellence in Education in Mathematics winner, one a state finalist for the Presidential Award for Excellence in Education in Science, and the third a finalist in the Pennsylvania Teacher of the Year Awards. The project has had the unplanned effect of providing student access to some of the best teachers in the state.

Recruiting efforts for the 1988-89 project have yielded responses from 20 additional teachers. We cannot predict the number which will come into the project at this time.

Objective 5: To have the course on line in November of 1986.

The course was not operational until March 1, 1988. By this time the students had developed school patterns which did not include doing independent study calculus. We have found that the students who are in school which are very supportive of the project are most likely to work steadily with the lessons. This is currently occuring at two of the three schools we are serving.

A major problem we had in the first year of the project was a chronic underestimation of the time it takes to develop materials. We began the second year of operation with lessons through chapter 4 but found it necessary to rewrite after students completed chapter 1 lessons. The rewritten lessons have been well received by the students. We will hopefully begin our third year with lessons we can use and concentrate more of our efforts on operating the course and interacting with students.

Objective 6: Determine the cost of continuing the course after the development money has been spent.

To determine the cost of continuation, we surveyed the timesheets of the secretarial help in the PDE project. For any day when the major activity listed related to servicing students, the entire day was counted. We attempted to err on the side of overestimating expenses. Timesheets were used beginning with January 4, 1988. This proved to be a convenient reference due to the fact that all of the students doing lessons in the project were working by that time.

The secretarial activities included copying disks, assembling worksheets, preparing mailings and correcting errors. School was in session 73 days for the period when the data was collected. We logged 75.5 hours of secretarial time to provide services. These are minimum wage jobs which pay $3.75 including benefits. The secretarial cost per student per day to continue providing lessons is estimated at

75.5 hr x $3.75/hr x 1/20 students x 1/73 days =
$0.19/student/day

Professional services to students have been minimal. An estimate of 1.5 hr/week would be high. We chose to use that figure.

The cost per hour is based on a teacher's salary plus fringe benefits costing $30,000/year. Teachers at Chestnut Ridge work a 7.5 hr workday with a half hour for lunch and a 182 day year. Using seven hours per day yields

$30,000/year x 1 year/182 days x 7 hr/day = $23.55/hr

At 1.5 hours per week the cost per student per day for professional services is

1.5 hr/week x $23.55/hr x 1 week/5 days x 1/20 students = $0.35/student/day

Materials include computer disks, paper, and printing. $2.00/student/year = $0.01/student/day

Total cost for continuation of the course:

Secretarial	$0.19/student/day
Professional	$0.35/student/day
Materials	$0.01/student/day
Phone charges	$0.10/student/day
Training	$0.13/student/day
Total	$0.78/student/day

Annual cost per student to continue course is $140.

Objective 7: Evaluate the cost effectiveness of providing instruction by this method.

The cost to continue the course is a statement of the price we would need to charge other schools to distribute materials and evaluate student performance for their students. Cost effectiveness should compare the entire cost of providing instruction by this method to the cost of teaching the course using an instructor teaching with traditional techniques.

We will use the $23.55/hr derived in the previous section as the cost per hour of a teacher. The estimate of teacher time to teach a class of 20 students is 200 minutes per week plus 60 minutes of preparation. The cost of a calculus teacher is then:

260 min/week x 1 hr/60 min x $23.55/hr x 1/20 students

x 1 week/5 days = $1.02/student/day

To measure the cost effectiveness of offering calculus using CRISP we must include the cost of the computer at the students school and the costs of maintaining the equipment at Chestnut Ridge. Computers at Chestnut Ridge High School and the Regional Computer Resource Center at the University of Pittsburgh at Johnstown are completing their sixth year of service with an average use of approximately five periods per day. These computers are still in use which will make our estimate high. Using a purchase price of $800 for a computer, we estimate the cost per period of use to be:

$800 x 1 yr/180 days x 1/6 yr x 1 day/5 periods =

$0.15/computer/period

Fixed costs include the cost of updating and maintaining our equipment, phone bill, and office supplies. Since the cost per student will decrease with increased student numbers, we estimated the fixed costs based on serving 1000 students. Our estimate is $0.06/student/day

Total cost of providing calculus to schools:

Services to student	$0.78/student/day
Computer costs	$0.15/student/day
Fixed costs	$0.06/student/day
Total	$0.99/student/day

The estimated annual cost for a school to teach with CRISP becomes $178.

The cost of offering the CRISP independent study calculus course compares favorably with the cost of providing instruction by traditional methods. Several additional factors should be considered when discussing costs.

The calculus course was designed to be continuously improved through the evaluation of the student answer files. This will require additional professional time to be included in the cost of the course. Adding $0.15/student/day to the cost of CRISP would bring the cost up to $1.14/student/day which would be higher than the cost of traditional education. This would provide $27,000 of revenue to improve the course if the course served 1,000 students.

The ultimate goal of this project is to develop a service which can become self supporting. If this project is able to grow it should realize economies of scale which would reduce the cost/student/day. Duplication of disks and preparation of written materials can be done more cost effectively when we reach the point where lessons are bug free and disks are copied using a single setup procedure on several machines. Combined with the fact that our time estimates were intentionally high in our cost analysis leads to optimism that CRISP can grow and prosper.

The last point to remember is that the cost analysis does not include the initial cost of course development. This project spent $5,643 on lesson development and the PDE/CRISP project has invested approximately $4,000 on additional lesson development. We have approximately 90 lessons completed at this time. A safe estimate would be that it takes $25,000 to develop a course to use with CRISP if you have the trained personnel available.

Objective 8: Evaluate student achievement.

Because of the circumstances of this year's project (rewriting lessons as students were doing them) we were not able to do a well planned evaluation of student achievement. The chapter 1 tests which were developed with the old methods were not keyed to specific objectives as are the new lessons produced when chapter 2 was rewritten. They were usable as a general indicator of student achievement but not specific enough to evaluate lesson effectiveness.

We do have some data for quizzes taken by students who did the revised chapter 2 lessons. The design of the chapter 2 lessons shows an evolution from a concept of a lesson being designed as one day's work for the student to a concept where a lesson must contain nine separate steps to be considered complete. This lesson design model was was developed with the assistance of Dr. Kyle Peck at Penn State as part of the teacher training done under the PDE contract. The model is based on the nine events of instruction of Robert Gagne (Gagne, Wager, and Rojas, 1981).

There is a steady improvement in the class mean for these quizzes as the lesson design evolved to the methods used when lesson development was concluded for the year. The class mean for the Chestnut Ridge students was 70% for the first quiz, 79.3% for the second, and 86.3 for the third. The quiz covering the lessons with the best design had the highest mean.

The following table shows how many questions were answered correctly by what percentage of the class. This data was only available for Chestnut Ridge Students as they were the only students to return all three sets of chapter 2 quizzes.

Number of students who answered __ percent of the questions correctly.	Quiz 1	Quiz 2	Quiz 3
6	33%	45%	53%
5	21%	17%	34%
4	17%	21%	17%
3	8%	14%	5%
2	8%	0%	0%
1	8%	3%	0%
0	4%	0%	2%

For example: All of the students answered 33% of the quiz 1 questions correctly, 45% of the quiz 2 questions, and 53% of the quiz 3 questions. 21% of the quiz 1, 17% of the quiz 2, and 34% of the quiz 3 questions were answered correctly by five of the six student who took the tests. For quiz 1, 54% of the questions were either correct for all of the students or missed by only one. By quiz 3, the number had increased to 87% of the questions correct for all students or missed by only one.

Performance on the quizzes definitely increased as the lesson design evolved. Part of this increase can be attributed to the nature of the material tested, but another part is due to the fact that our lessons began to teach what we wanted to test. Instructional designers call this congruence between the objectives, lesson, and test.

Other evidence which suggests that our methods of lesson design were improved at the end of this year's project was gathered from the student evaluations we had collected. We initially asked for student evaluations in December as the Excellence in Education Project was ending. The only test data available at that time was the results of the chapter 1 test which we mentioned previously was too general to be used as a direct lesson evaluation.

We requested and received an extension for the due date of our final report submission in the hopes that we might be able to provide a more detailed evaluation of the performance of the project at that time. The chapter 2 quiz results, and the cost figures to offer calculus using CRISP were gathered during this time period.

Student evaluations were requested again at the end of the school year. These evaluations requested open ended responses to the same questions which were posed in December and included one additional question.

The student responses we received in December indicated our lessons were difficult to follow and left an unfavorable impression of the course with our students. It was after these evaluations that the decision was made to rewrite the chapter 2 lessons before they left Chestnut Ridge. Student comments at the end of year evaluation indicate that rewriting the chapter 2 lessons was a wise decision.

The students responses to the open ended questions from December and their responses after the lesson revisions are provided below. The prerevision and postrevision responses are not provided for identical student populations. Five students missed in the December evaluation are included in the final. The Middleburg High School students are included with the first group. They joined the project in January and completed lessons through chapter 2 quiz 1. Since they did very few of the revised lessons, their comments are included with the December comments.

The results are listed for the total group and by school. CR is Chestnut Ridge; SF, Southern Fulton; NB, Northern Bedford; and M, Middleburg. The question we asked is listed with the responses the students supplied.

ARE THE OBJECTIVES CLEAR TO YOU?

	PREREVISION					POSTREVISION				
	CR	SF	M	TOTAL	%	CR	SF	NB	TOTAL	%
YES	3	0	2	5	42	2	3	2	7	58
MOST OF THE TIME	1	1	2	4	33	4	0	0	4	33
NEGATIVE RESPONSE	0	2	1	3	25	1	0	0	1	9

Before the revision 75% of the students said the objectives were clear at least most of the time. After revision of lesson development methods 91% said objectives were clear at least most of the time.

WHEN YOU COMPLETE A LESSON DO YOU FEEL IT HELPED YOU ACHIEVE THE OBJECTIVES?

	PREREVISION					POSTREVISION				
	CR	SF	M	TOTAL	%	CR	SF	NB	TOTAL	%
YES	0	0	0	0	0	2	3	2	7	58
MOST OF THE TIME	2	0	1	3	25	4	0	0	4	33
SOMETIMES	2	1	2	5	42	1	0	0	1	9
NEGATIVE RESPONSE	0	2	1	3	25	0	0	0	0	0
OTHER	0	0	1	1	8	0	0	0	0	0

None of the students answered this question with a definite yes before the revision and 25% of the group responded in a negative way to the question. After revisions we had 58% unqualified yes responses and no negative responses. Ninety one percent of the students responded positively to this question after revisions as opposed to 25% positive before.

ARE THE EXPLANATIONS CLEAR?

	PREREVISION					POSTREVISION				
	CR	SF	M	TOTAL	%	CR	SF	NB	TOTAL	%
YES	0	0	0	0	0	3	2	2	7	58
MOST CASES	1	1	2	3	25	4	0	0	4	33
USUALLY NO	1	0	1	2	17	0	0	0	0	0
NO	2	2	0	4	33	0	1	0	1	9
SOME YES SOME NO	0	1	2	3	25	0	0	0	0	0

Only 25% responded with a yes or a statement which would indicate the explanations are usually clear pre-revision. Ninety one percent responded positively after the revision. These results match the student responses to the question "Did the lesson help you achieve the objectives".

HOW WOULD YOU RATE THE PACING OF THE LESSONS?

	PREREVISION					POSTREVISION				
	CR	SF	M	TOTAL	%	CR	SF	NB	TOTAL	%
TOO FAST	1	0	3	4	33	0	1	0	1	8
GOOD	1	3	2	6	50	2	2	1	5	42
USUALLY GOOD	1	0	0	1	9	1	0	0	1	8
TOO SLOW	1	0	0	1	8	3	0	0	3	25
ANSWERS DON'T FIT OR NO ANSWER	0	0	0	0	0	1	0	1	2	17

Fewer students rated the lessons as too fast after revision but others apparently saw the increased detail of the lessons as making them too slow. Branching techniques we hope to introduce next year should help those who felt the lesson was too slow and make the instruction more efficient. These conclusions are also reinforced by the student's responses when asked if there are weaknesses in the lessons and if so what they are. The students responded:

	PREREVISION					POSTREVISION				
	CR	SF	M	TOTAL	%	CR	SF	NB	TOTAL	%
EXPLANATIONS NOT CLEAR	3	3	5	11	92	0	0	0	0	0
PACE TOO SLOW	0	0	0	0	0	2	0	0	2	17

The before and after comments are dramatic. The previous conclusions are further supported.

DO YOU FEEL THERE ARE ANY PARTICULAR STRENGTHS TO THESE LESSONS?

	PREREVISION					POSTREVISION				
	CR	SF	M	TOTAL	%	CR	SF	NB	TOTAL	%
SELF-PACING	1	1	1	3	25	2	2	0	4	33
ABILITY TO REVIEW	0	0	0	0	0	2	2	1	5	42
LEARN ABOUT COMPUTERS	0	1	0	1	9	0	1	0	1	9
CAN BE USED IF A SCHOOL DOESN'T HAVE CALCULUS	0	1	0	1	9	0	0	0	0	0
RESPONSIBILITY FOR LEARNING IS PLACED UPON THE STUDENT	1	0	0	1	9	0	0	0	0	0
EXAMPLES ARE HELPFUL	1	0	0	1	9	0	1	1	2	17
EASY TO UNDERSTAND	0	0	0	0	0	1	0	1	2	17
MUST ANSWER THE QUESTIONS	0	0	0	0	0	1	0	0	1	9
GET IMMEDIATE FEEDBACK	0	0	0	0	0	2	0	0	2	17
LESSONS CHECK HOMEWORK	0	0	0	0	0	1	0	0	1	9
COMPUTER FOCUSES ATTENTION BETTER THAN A TEACHER	0	0	1	1	9	0	0	0	0	0
LIKE THE CONVERSATIONAL TONE	1	0	0	1	9	0	0	0	0	0
NONE	0	0	3	3	25	0	0	0	0	0

This question provides insight into student attitudes regarding the lessons. In responding to this question before the lessons were revised the students only listed two advantages which were actually designed into the lessons. The remaining advantages listed would be true if the student were handed a textbook and given an independent study course. Three students had no positive comments regarding the lessons. After the revisions were made the students responded by listing six different features that are specifically related to our goals in designing the lessons. This reflects a positive shift in attitude toward the lessons. A final indicator is provided when students were asked if they believed they learned from this course.

DO YOU FEEL YOU LEARNED FORM THIS COURSE?

	PREREVISION					POSTREVISION				
	CR	SF	M	TOTAL	%	CR	SF	NB	TOTAL	%
YES	2	1	1	4	33	5	2	1	7	58
YES WITH SOME QUALIFICATIONS	2	0	2	4	33	2	1	0	3	25
NO	0	2	2	4	33	0	1	0	1	9

Once again the increase in positive attitude toward the lessons can be seen in the responses.

Student responses to the question "DO YOU FEEL THERE ARE WEAKNESSES IN THE LESSON? IF SO, WHAT ARE THEY?" other than the responses mentioned earlier included the following:

	PREREVISION					POSTREVISION				
	CR	SF	M	TOTAL	%	CR	SF	NB	TOTAL	%
LACK OF A TEACHER	0	3	1	4	33	1	3	0	4	33
COMPUTER BUGS AND ERRORS	0	0	2	2	17	1	0	0	1	9
TAKES TOO LONG TO GET AN ANSWER TO A QUESTION	0	1	0	1	9	2	0	1	3	25
DIDN'T LIKE THE QUESTION FORMAT	0	0	0	0	0	1	0	0	1	9

The problem of computer bugs will diminish as lessons continue to be tested. The lack of a teacher is a problem that can't be resolved. This project exists because the students did not have a calculus teacher for some reason. The students perceived weaknesses in the lessons and disadvantages of learning calculus this way as the same set of problems. When asked "WHAT DO YOU CONSIDER TO BE THE DISADVANTAGES OF LEARNING CALCULUS THIS WAY?" they responded with the same set of comments regarding the explanations and pacing, then listed the almost the same comments as the previous table.

	PREREVISION					POSTREVISION				
	CR	SF	M	TOTAL	%	CR	SF	NB	TOTAL	%
LACK OF A TEACHER	2	1	2	5	42	1	1	1	3	25
COMPUTER BUGS AND LESSON ERRORS	1	2	0	3	25	0	0	0	0	0
TAKES TOO LONG TO GET AN ANSWER TO A QUESTION	3	2	0	5	42	2	2	0	4	33
NOTATION SYSTEM	0	0	0	0	0	1	0	0	1	9
MISSED INPUT FROM OTHER STUDENTS	0	0	0	0	0	1	0	0	1	9

It was our opinion that the major problem was insufficient communication between the student and teacher. Increasing communication would help to reduce the criticism that it takes too long to get a question answered and might help with the student's desire to have a teacher. The weak communication was a result of insufficient student training in telecommunicaitons at the beginning of the year and hardware problems at one school. Given our lesson production needs we were unable to address these problems even though we were aware of them.

To address this problem next year we are investigating the possibility of programming our computer to call the student's computer at night when phone rates are lowest to increase the monitoring of student responses to the questions in the lessons and give the student the ability ask questions as they do the lesson. This would allow is to carry on a dialog without the student having to call us during class time. The other alternative is to require the student to frequently upload their answer files.

The types of responses to "WHAT DO YOU CONSIDER TO BE THE ADVANTAGES OF LEARNING CALCULUS THIS WAY?" were similar to the responses when asked if the lessons had strengths. The students apparently equate the strengths and weaknesses of the lessons with the strengths and weaknesses of the course.

	PREREVISION					POSTREVISION				
	CR	SF	M	TOTAL	%	CR	SF	NB	TOTAL	%
SELF-PACING	2	1	3	6	50	6	2	0	8	67
ABILITY TO REVIEW LESSONS	0	2	1	3	25	1	0	0	1	9
OPPORTUNITY TO LEARN COMPUTERS	0	2	0	2	17	1	0	0	1	9
GOOD FOR SCHOOLS WHICH DON'T OFFER CALCULUS	2	1	0	3	25	0	1	0	1	9
LEARN TO WORK INDEPENDENTLY	0	0	0	0	0	1	0	1	2	17
GOOD EXAMPLES	0	0	0	0	0	0	0	1	1	9
LESSONS ARE EASY TO UNDERSTAND	0	0	0	0	0	0	1	1	2	17
GIVE STUDENT FLEXIBILITY IN SCHEDULING CALCULUS	0	0	0	0	0	1	0	0	1	9
PROVIDES AN OPPORTUNITY TO USE COMPUTERS	0	1	0	1	9	0	0	0	0	0
NO ANSWER	0	0	2	2	17	0	0	0	0	0

The question asked on the final evaluation which was not asked in December was "DO YOU THINK THIS PROJECT CAN PROVIDE MEANINGFUL CALCULUS INSTRUCTION?.

	PREREVISION					POSTREVISION				
	CR	SF	M	TOTAL	%	CR	SF	NB	TOTAL	%
YES	*	*	0	0	0	3	1	2	6	50
YES WITH SOME QUALIFICATIONS	*	*	3	3	60	4	2	0	6	50
NO	*	*	1	1	20	0	0	0	0	0
NO ANSWER	*	*	1	1	20	0	0	0	0	0

* This question did not appear on their questionaire.

All of the students who completed postrevision lessons responded positively. Qualifying comments referred to the need for student motivation, improving the operation of the project, and the fact that it is more difficult without a teacher.

EXPENDITURE OF MONIES

Budget Category	Amount Spent
Personnel	$10314.45
Fringe Benefits	$1347.66

Personnel and fringe benefit costs supported the development of lessons, time required to make the system compatible with other computer equipment (hardware), development of the lesson authoring system, administration of the program including recruitment of test schools, training of teachers and students at other schools, and operation of the course. The percentages of times used in each of these categories is:

Lessons	46%
Hardware	7%
Authoring system	24%
Administration	12%
Training	9%
Operation	2%

Approximately 31% of the costs from these categories ($3615) are essentially one time costs.

Travel $ 402.25

Travel to schools to set up visits, meet with consultant, present project at Pennsylvania Association of Rural and Small Schools, present project at National Rural and Small Schools Consortium convention.

Equipment $1357.55

Equipment purchased included a $207.92 chip kit to upgrade the processing speed of the Tandy 6000. The remainder of the equipment budget was spent on modems and connecting cards. The modems were placed in computers of participating schools and one of the teacher authors.

Supplies $ 154.43

Supplies included computer disks, a printer ribbon, and tape and a dispenser for mailing packages.

Other $1114.97

Other included the services of a consultant, computer disks, a word processor program, and calculus materials and textbooks.

Indirect $ 308.49

Indirect costs were used to offset mailing and telephone expenses. Only $11.26 was charged as actual indirect costs by the Chestnut Ridge School District.

DEMOGRAPHICS

There were 20 students enrolled as system users in our program at the completion of the 1987-88 school year. These students are located at four different high schools. Ten students are female and ten male.

The students at the remote schools did not respond to my questionaire concerning family income and ethnic background. Being from an outside school district we did not press the point.

Each of the school districts served appears to be similar in wealth and resources to the Chestnut Ridge School District. The following paragraphs describe Chestnut Ridge.

The area comprising the Chestnut Ridge School District is basically rural and relatively undeveloped. The high availability and low cost of land for housing tends to explain the population growth of the district. Another factor contributing to the population trend is the relative stability of the basis population of the school district which is comprised mostly of rural landowners.

Most of our residents work outside the district. Their occupations are fairly diverse, and those laid off tend to stay home and farm to supplement their lost income, rather than moving from the area to seek other employment.

Approximately 99.7% of the district's residents are Caucasion with the majority having German, English, or multiple ethnic backgrounds. German-American is by far the largest single ethnic group. Approximately 16% of the residents are 60 years of age or older. Approximately 50% are in the 19 to 59 year age bracket of wage earners while approximately 24% lie in the 5 to 18 year old school age bracket. The 1980 U.S. Census reported the median household income as being $13,606. This would probably be somewhat lower at this time due to the economic slowdown. During the 1984-85 school year 43.8% of our students participated in the subsidized lunch program. The median family income of the Chestnut Ridge participants in this project is in the $15,000-40,000 per year range. All are Caucasian.

Both Southern Fulton and Northern Bedford school districts are rural and similar in family wealth to Chestnut Ridge. They both have smaller student populations. Middleburg High School is one of two schools in the Midd-West School District. Middleburg is a small town school similar in size to Chestnut Ridge. West Snyder, the other school in the district is smaller than Chestnut Ridge and rural.

REPLICATION OF THIS PROJECT IN OTHER SCHOOLS

The very design of this project makes it transportable to other schools. One of the initial requirements set when we began to write lessons was that we needed to design a method which would work with any brand of computer encountered. The Reader program we wrote allows a teacher to use any word processor which can save documents as ASCII files to write lessons which can be used on the brand of computer available at that school. Lessons can be written on one computer brand and transported to a different operating system by using communications software.

This project has developed a simple way for teachers to create interactive individualized computer software for independent study. The Reader program saves student responses in the lesson for later analysis by the teacher. Knowing that their responses are recorded has provided the highest level of incentive to keep on task that we have witnessed in our students doing independent study activities.

The lesson authoring system is ready for immediate use in other schools. Lessons can be developed on a free authoring system which uses equipment and software which already exists in the school. A minimum, but essential, amount of training is needed to use the system to produce lessons. We have learned from this project that teachers should not undertake large curriculum development projects using our system without some training in instructional design.

The telecommunications component can also be implemented immediately by any interested school. Electronic mail is not an absolute essential for using the telecommunications component but does make it more convenient. Computer systems which use the Xenix operating system we have used can now be purchased for under $2000.

Lessons developed with our system could provide a new form of education for homebound or handicapped students. It can be used, as we have, to develop lessons for a course which is not presently available at a school.

The components which will be necessary for successful implementation are leadership and commitment by at least one agency. This will be absolutely necessary to hold the project together. This leadership could be provided by Chestnut Ridge for schools interested in using the materials we have produced.

We have the technological capability to offer our independent study courses nationwide. We will not attempt this until we have further developed and refined our lessons. We will also need to develop independent study materials to replace the site training we now do. If our proposal with Johns Hopkins is successful, we will have access to a nationwide test population.

IMPACT OF THIS PROJECT ON EDUCATION AT CHESTNUT RIDGE, THE REGION, AND THE STATE

Before the Excellence in Education Grant, Chestnut Ridge and Northern Bedford High Schools did not offer calculus in their curriculums. Calculus was taught at Chestnut Ridge by David Popp, director of this project, during preparation periods or through other arrangements with the student. Calculus will not be a part of the regular curriculum at these schools next year. Students at these school will have an opportunity to use the lessons developed by this and the PDE projects. Anticipated PDE funding for the next year will provide for the development of additional lessons.

This project has potential to provide needed lessons for gifted education. The development of four credits of in-service training for Appalachia Intermediate Unit 08 will provide us with the opportunity to carry this project to other schools in our region, train teachers in its use and in instructional design, develop materials, and share them among participating schools. One of these courses will be taught this August. The remainder of the training is planned for the summer of 1989.

This project has generated interest at the state level to the extent that three different projects have been funded through PDE. Chapter 2 reallocated monies purchased additional equipment and provide development of a mini-course Introduction to On-line Data Base Searching and additional calculus lessons. The PDE contract supported the calculus project this year and the beginnings of a physics course which is seen as one possible method of dealing with the impending shortage of physics teachers. The tele-accounting was supported by vocational education.

The project has been shared at the eight different conferences and workshops mentioned earlier. We are committed to the continued improvement of the project and hope to expand it to the point where it makes a significant contribution to students and school which are traditionally underserved.

CONCLUSIONS

The Excellence in Education Project at Chestnut Ridge did not prove that we have developed an effective method for providing independent study courses to students. It did reinforce the conclusions of a growing body of research which has concluded that the probability of a lesson being successful will increase if certain steps are included in the lesson design. Based on our own experience and the existing research we do not recommend the undertaking of major computer curriculum development projects by people who do not have a background in instructional design.

The data we were able to gather was more suggestive than conclusive. It suggested that students can learn using the CRISP system but it was not tested with the most difficult set of concepts. Student attitudes toward the lessons and performance on quizzes improved as the lesson design became more systematic but we worked with small samples of students and gathered only formative data.

We can improve our our evaluation procedures in the coming year using what we have learned from this project. Our claim of improved performance vs method of lesson design could easily be tested if we work with a larger population of students. The chapter 2 section one and two lessons which were redesigned were a hybrid of the old and new methods. We could redesign these lessons using our final techniques and compare performance of two groups, one using this year's redesigned lessons and another using a second revision, on the same quiz used this year. The information gathered during the free response student evaluations can be used to design student evaluations to measure attitudes toward specific issues raised by individuals.

The most promising aspect of future evaluations is that we will be able to take time to design them in advance because we now have a set of lessons which have been debugged and field tested. Rather than keeping one week, and in some cases one day, ahead of the students we can design instruments to measure the variables of interest before the students begin the lessons.

We do believe we have developed this project to the point where it demonstrates the potential to provide independent study materials to underserved students. Any school with a computer can use lessons developed with our system. Once the project is validated, the challenge will be to identify and train lesson designers and to disseminate the project to other schools.

PERSONAL REMARKS FROM THE PROJECT DIRECTOR

A 1974 study commissioned by the U.S. Office of Education and performed by the Rand Corporation concluded that the greatest indicator of success in implementing an innovative program is local need (Berman & McLaughlin, 1974; Berman & McLaughlin vols 2 & 4, 1975). If this project results in a permanent method used to bring independent study courses to students it will be due to the commitment to the success of the project at Chestnut Ridge.

I do not know the rationale of the U.S. Department of Education in awarding this grant to Chestnut Ridge. Our proposal addressed many of the needs described on the original request for proposals, we had an unusual amount of experience and resources in computers, but we had virtually no experience in instructional design. I see this as the most important asset if this project is to be successful. The computer experience allowed us to develop an innovative use of microcomputers but the lessons we delivered were mediocre.

My personal commitment to the project was such that I had entered a Ph. D program at Penn State in instructional systems. At Penn State I took one course in designing instructional software and met Kyle Peck who helped design the teacher training workshop for the PDE contract. The skills acquired from these activities permitted the lesson revisions which achieve results superior to those written earlier.

We learned that writing computer lessons cannot be done by untrained teachers and that training cannot be done in a two day workshop. Teachers need to develop their skills in steps where they can see the need for some of the methods which must be used.

If I were a grant reader, I would not fund our project as it was proposed in October of 1985 based on our lack of experience in instructional design. Our experience and creativity with computers created the delivery system, but the lessons writtten at that time failed. If the proposal was able to convey the degree of commitment we had, I would recommend funding. The success of a project such as this depends on the commitment and ability of the personnel as well as their backgrounds.

This grant has provided me with the resources that I needed to develop a solution to a problem which has plagued me for 18 years as a teacher in a small rural school, how to provide an education which will make my students competitive with others when they leave Chestnut Ridge. I plan to remain with the project created by the Excellence in Education Grant and hope to develop it to the point where it can one day become self supporting at a price which will make it affordable by any school.

At this time the project will not continue without government support. Our experiences with the project lead us to conclude that we will need to have a finished product before we can establish ourselves as an agency which inspires sufficient confidence to encourage others to join with us.

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CHESTNUT RIDGE INDEPENDENT STUDY PROGRAM

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